Structure of Cocoa-based Agroforestry Systems and their Productivity in Talamanca, Costa Rica

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Cocoa- based Agroforestry systems : how the variability of their high structural complexity….

- Low input & based on workforce
- High specific diversity
- High intra and inter heterogeneity
- Differenciate management of the components
- High diversity of man uses

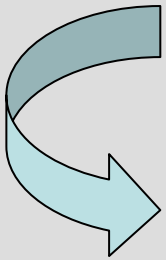
…is affecting their productivity ?

Performances of cocoa based AFS : a controversial topic

- Until recently (1990's), NOT considered as an acceptable option regarding cocoa productivity, especially compared to that obtained in cocoa monocropping systems (Ruf, 2009)

- Highlighted today for their productive performances (Malezieux & al., 2008; Harvey & Villalobos, 2007;Harvey et al., 2006; Schroth et al., 2004; Dahlquist et al., 2007)

- But extremely few papers try to understand the impact that structure variability has on agronomical performances (Steffan-Dewenter & al., 2007)



Our objectives :

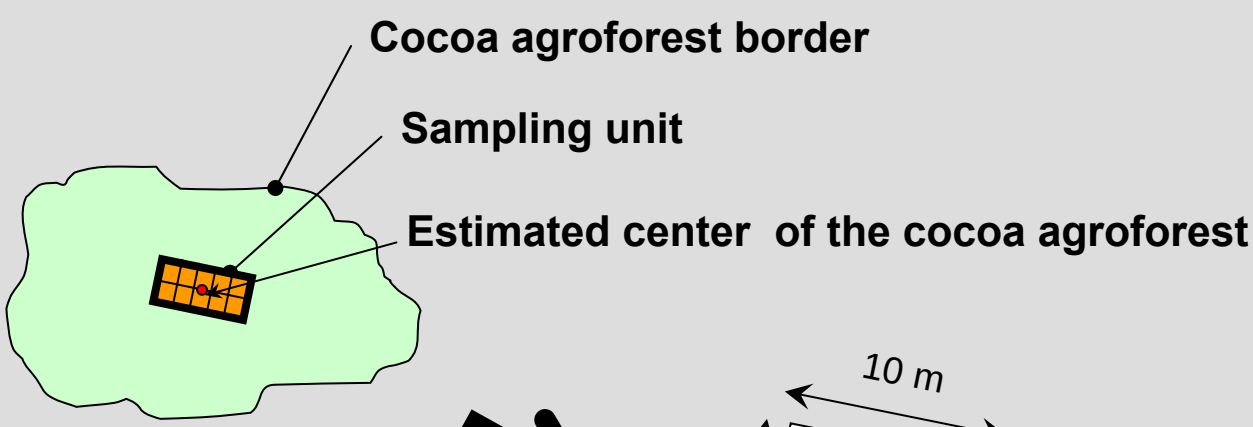
Link a given cocoa orchard structure with its cocoa yield

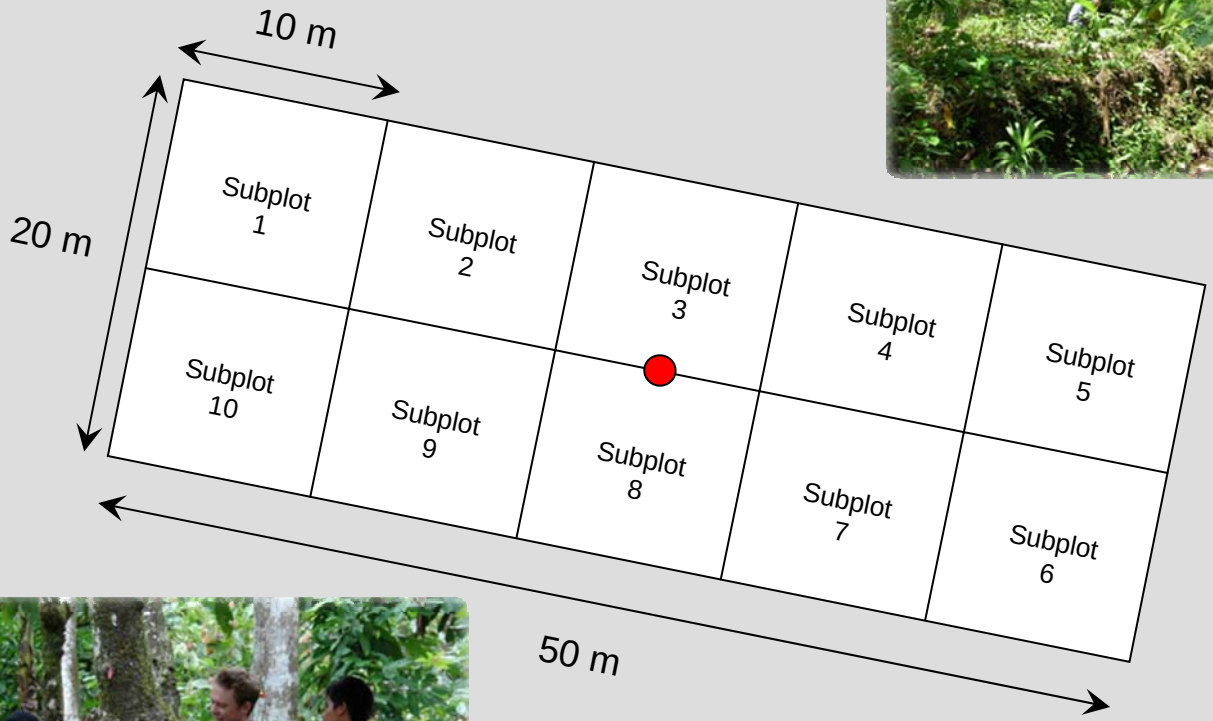
Be able to rank cocoa agroforests according to their trade-offs between Productivity and Structure complexity

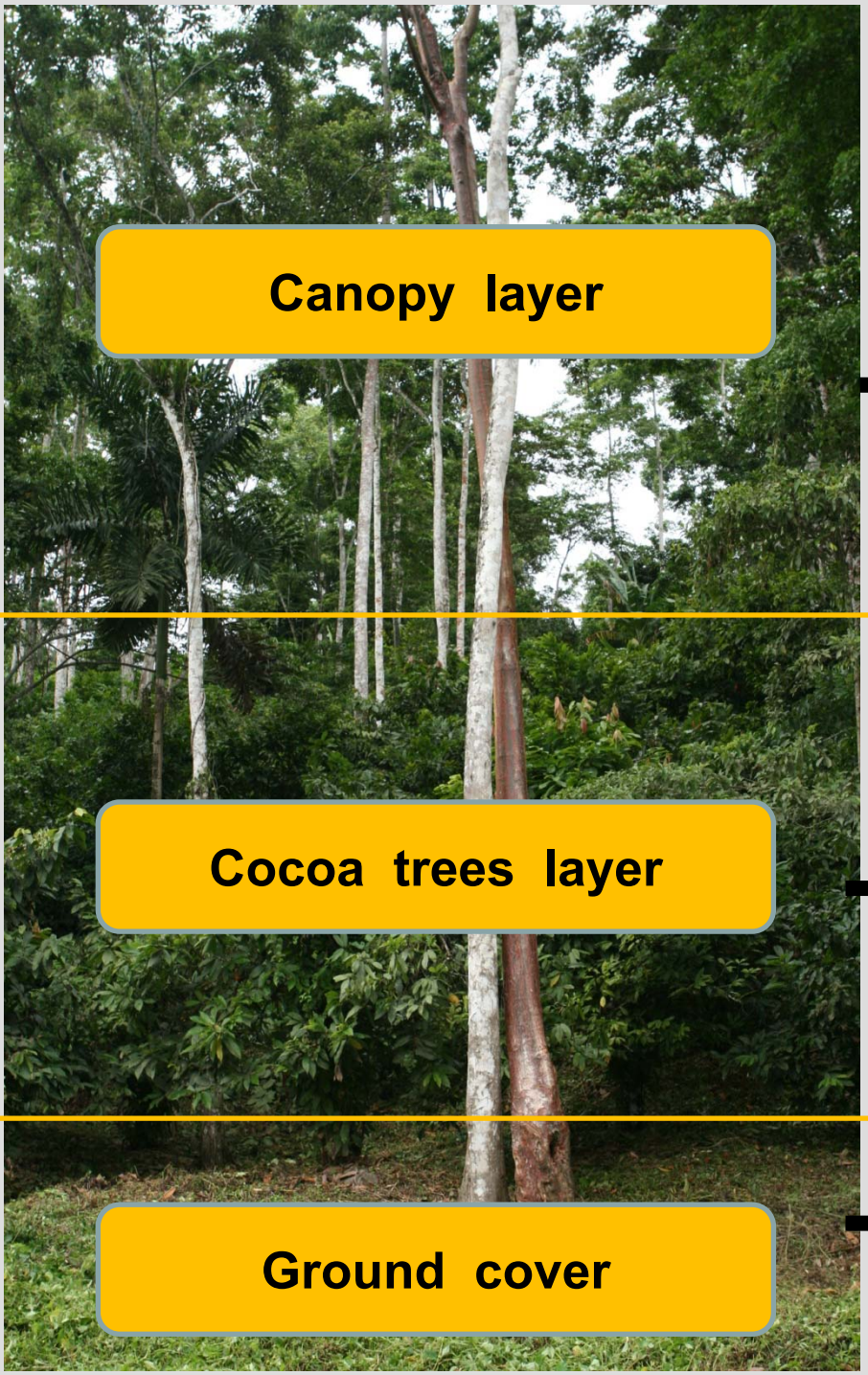
The Talamanca region, Costa Rica

- 36 cocoa AFS selected to maximize contrasts in terms of associated plant species and density, topographical context and landscape context.
- Aged 4 to 57 years – Area : 0,5 to 5 ha
- All under organic certification scheme

- Average T°C = 27°C
- P=3500–4500 mm /year
- Altitude 70 to 500 m
- Deep fertile soils (Winowiecky, 2008).


Cocoa agroforest border
Sampling unit
Estimated center of the cocoa agroforest


10 m
20 m
Subplot 1
Subplot 2
Subplot 3
Subplot 4
Subplot 5
Subplot 10
Subplot 9
Subplot 8
Subplot 7
Subplot 6
50 m



Canopy layer

- Associated plants ≥ 2,5 m were identified, counted and measured for dbh and height,

- Shade % at 1m height with densiometer on each subplot during dry and rainy season.

Cocoa trees layer

- Cocoa trees counted and measured for Ø 30cm and height

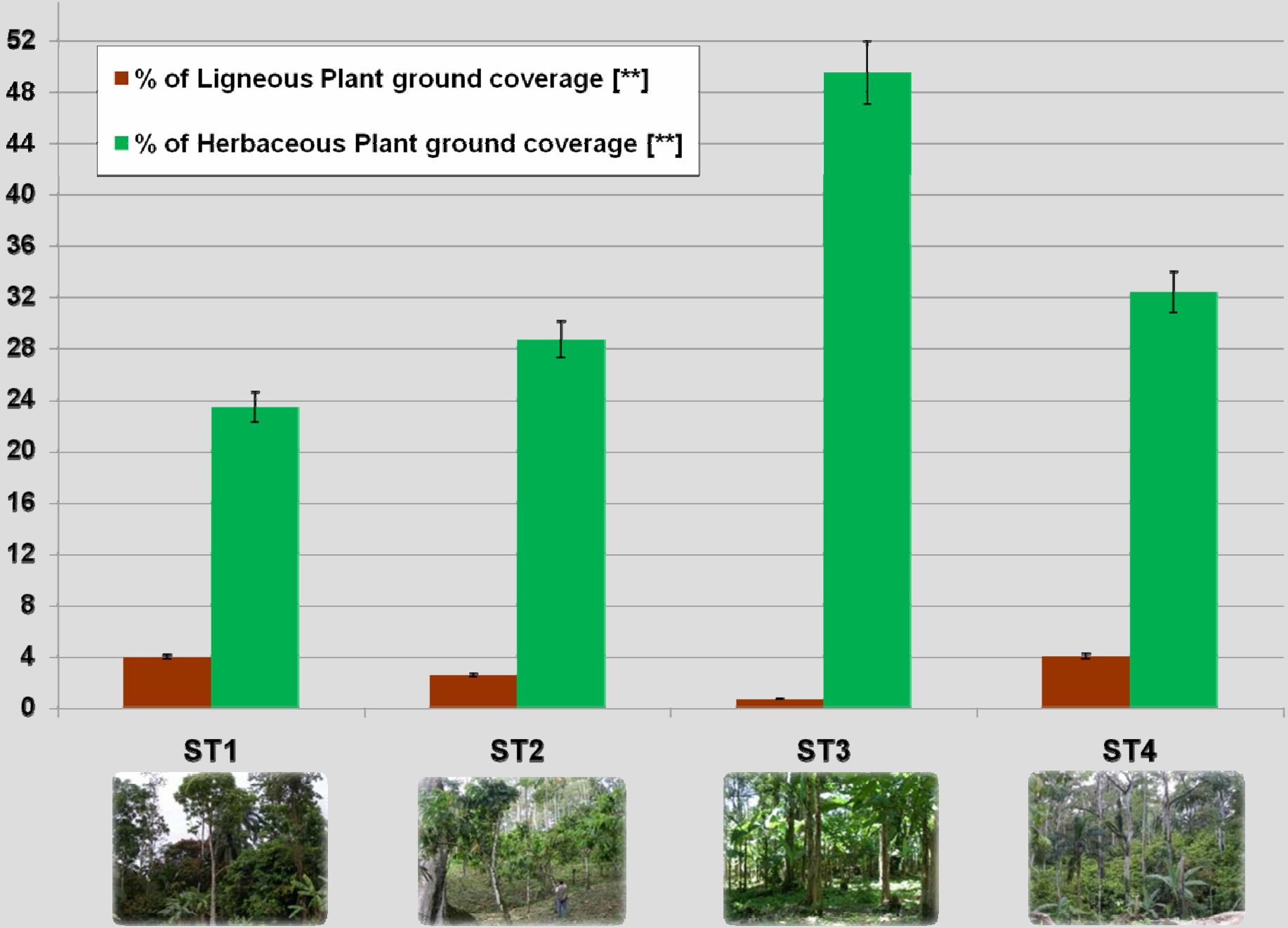
- Pods counted on all cocoa trees within the 1000 m² plot before each main harvest (April & October).

Ground cover

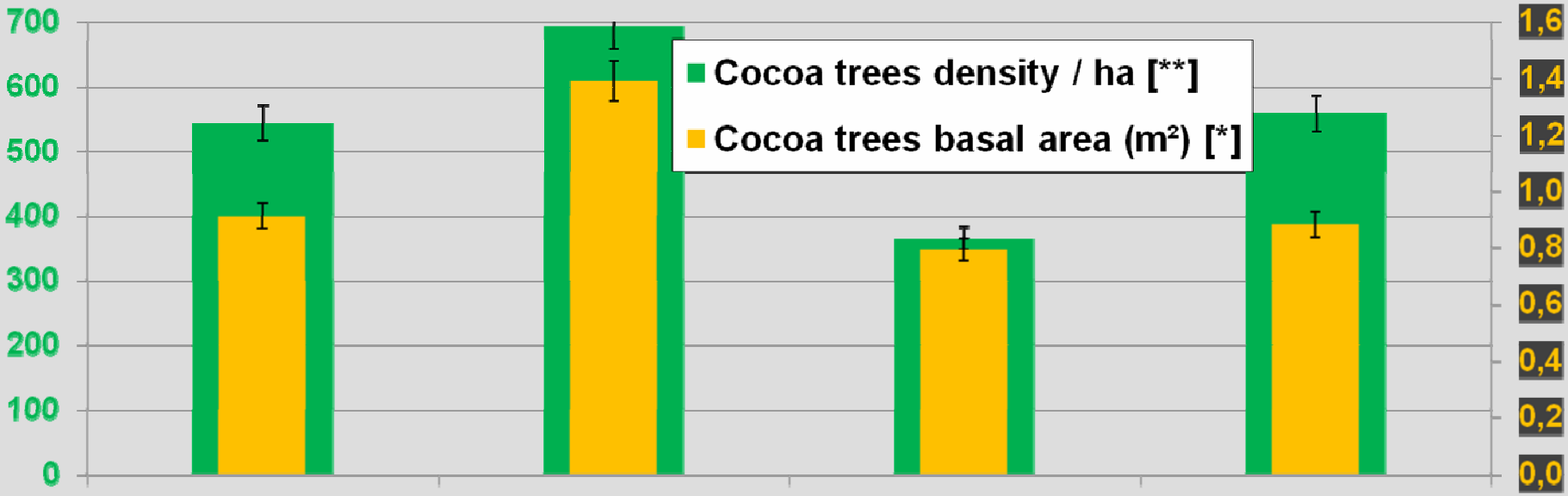
- 1 m² area on each subplot.

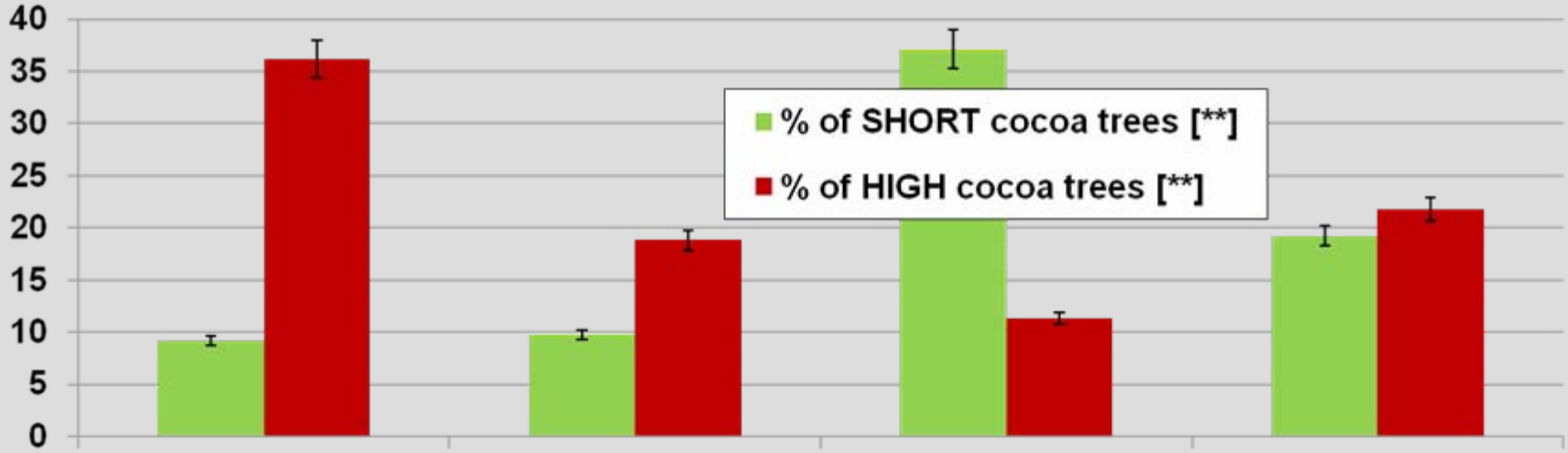
- 4 times / for : % of Ligneous, Grasses, Mosses, Ferns, and Litterfall

GROUND LAYER



COCOA TREES LAYER



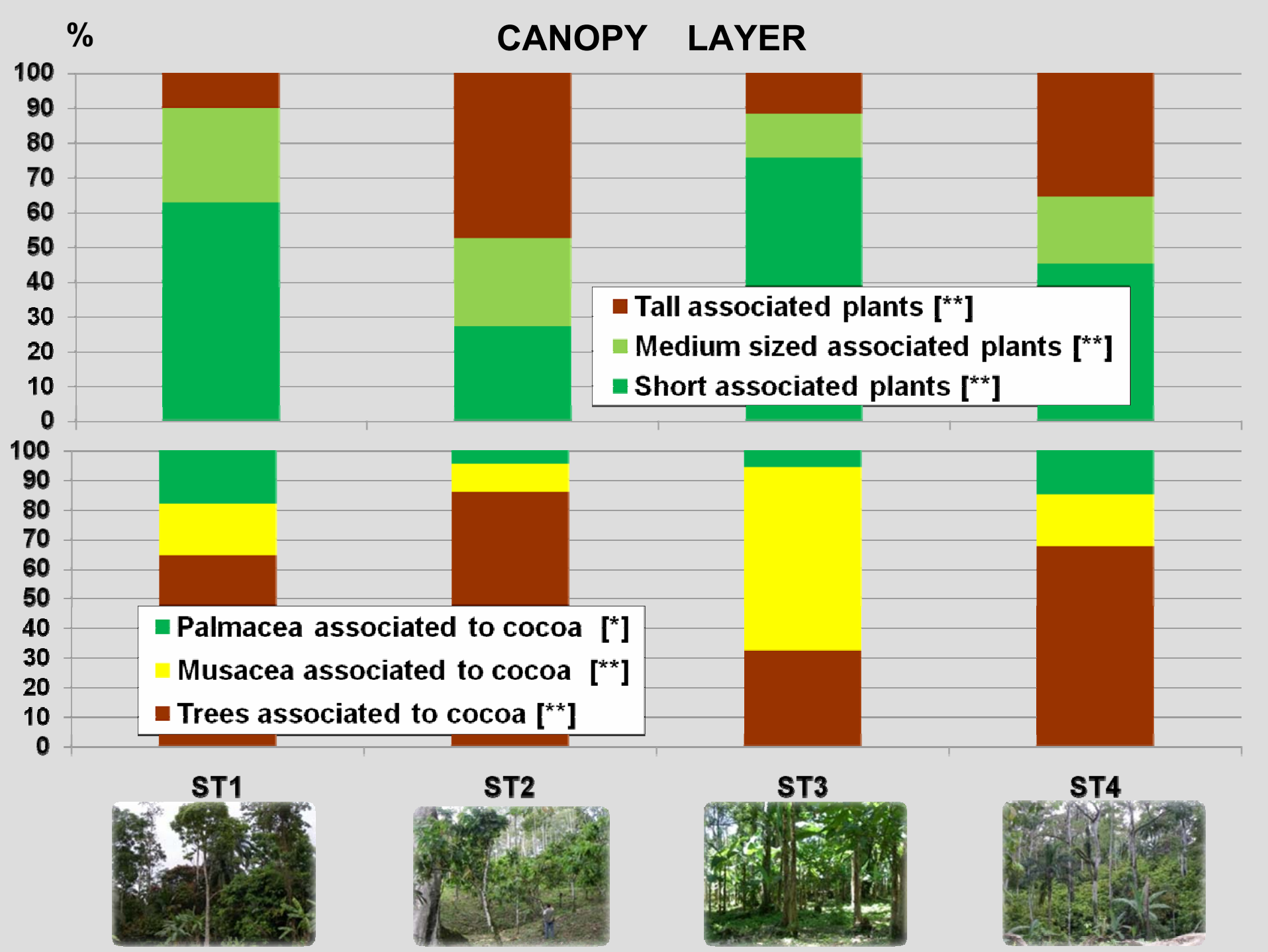


ST1

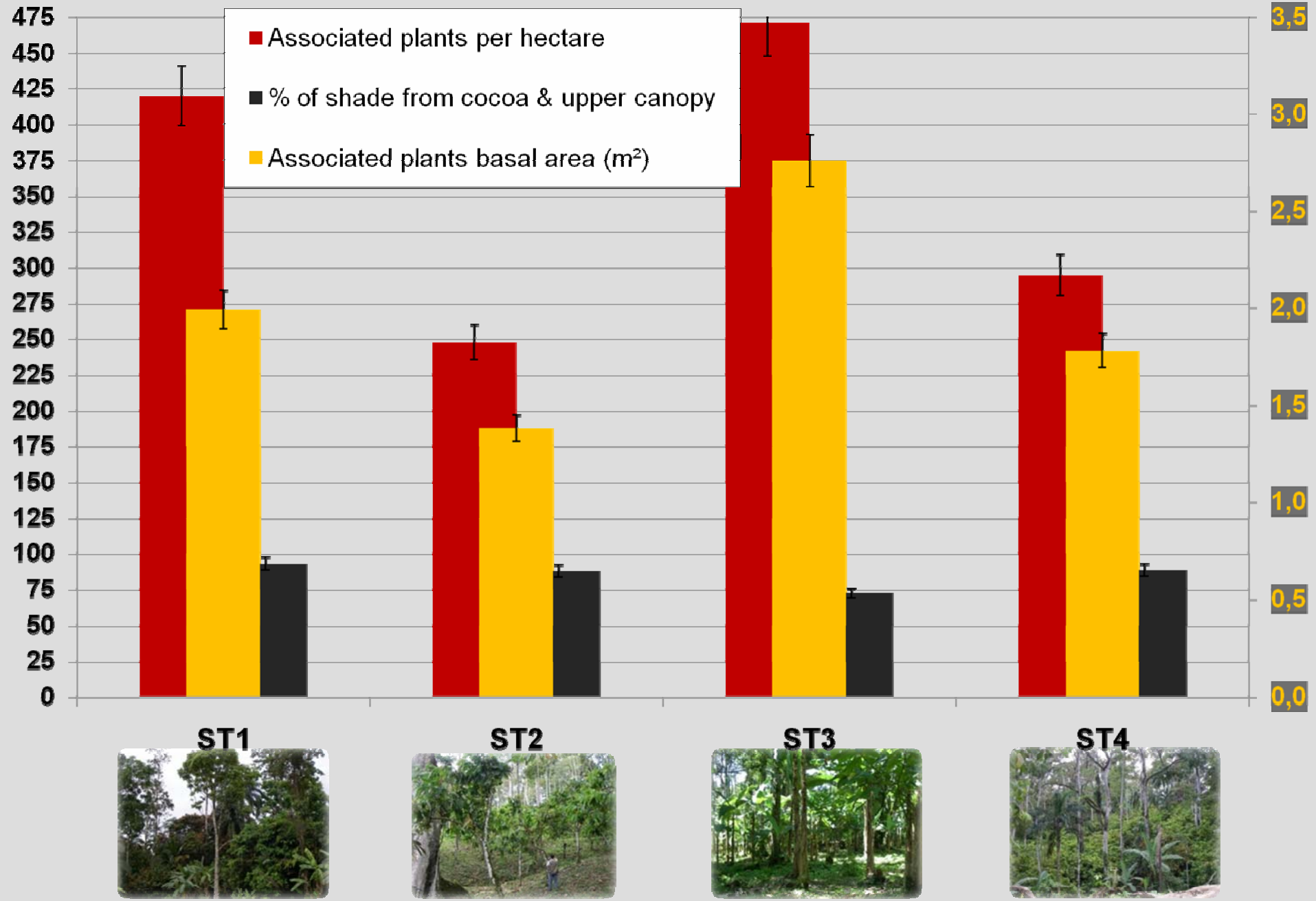
ST2

ST3

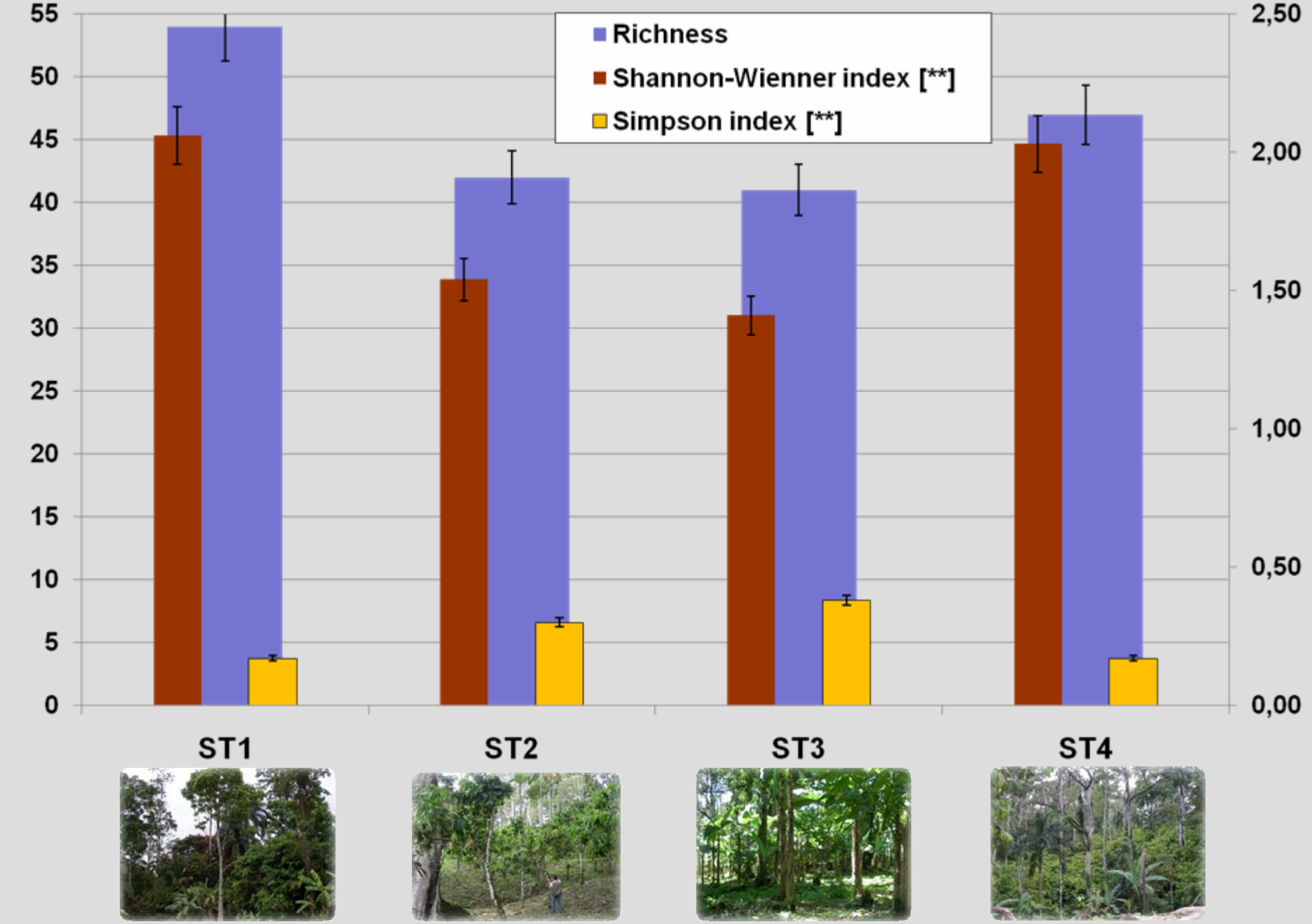
ST4


%
CANOPY LAYER
100
90
80
70
60
50
40
30
20
10
0
Tall associated plants [**]
Medium sized associated plants [**]
Short associated plants [**]
Palmacea associated to cocoa [*]
Musacea associated to cocoa [**]
Trees associated to cocoa [**]
ST1
ST2
ST3
ST4

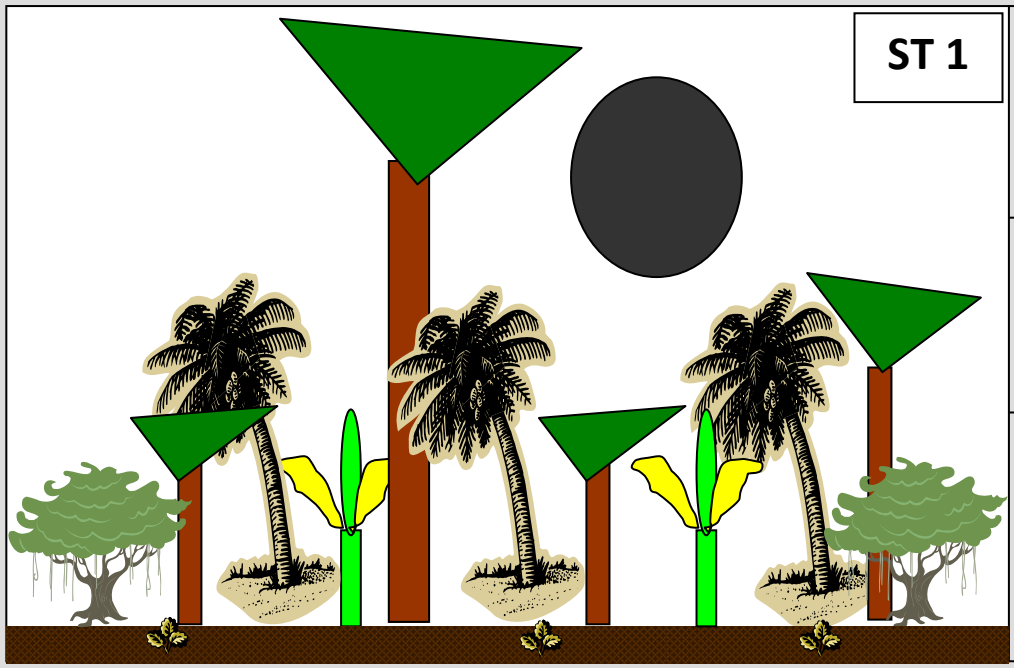
CANOPY LAYER



CANOPY LAYER



CLUSTERS DESCRIPTION

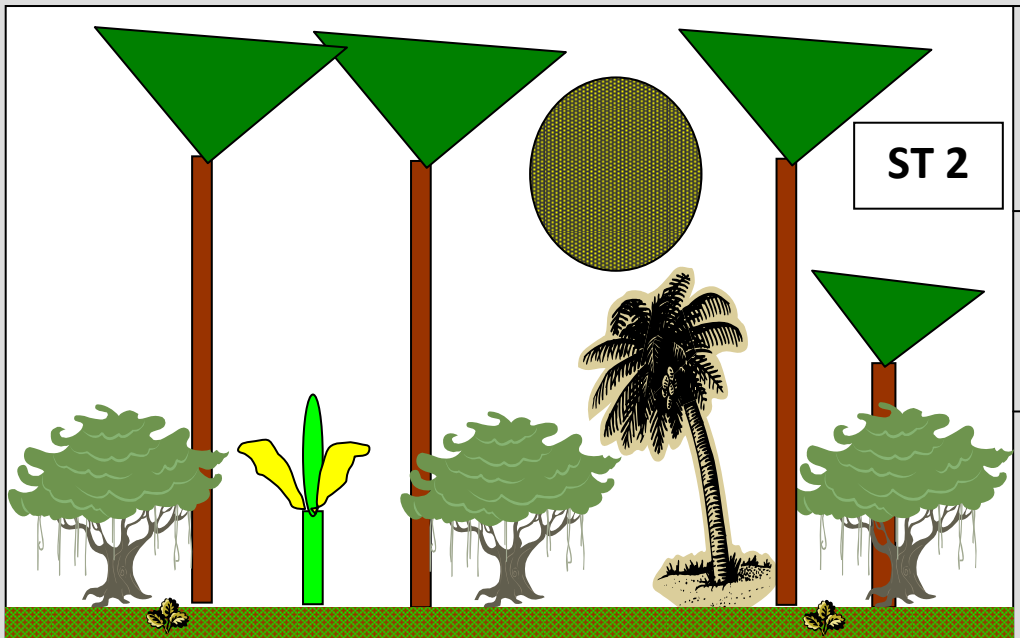


- High density of associated plants distributed in low and middle strata with a high stratum almost empty (65-25-10).
- High proportion of trees and Palmacea
- Average proportion of Musacea.

- Extremely high shade level at 1m height.

- High density of young, high but thin unpruned cocoa introduced varieties(90%).

- Ground covered with litterfall and young tree seedlings. Very little grasses.



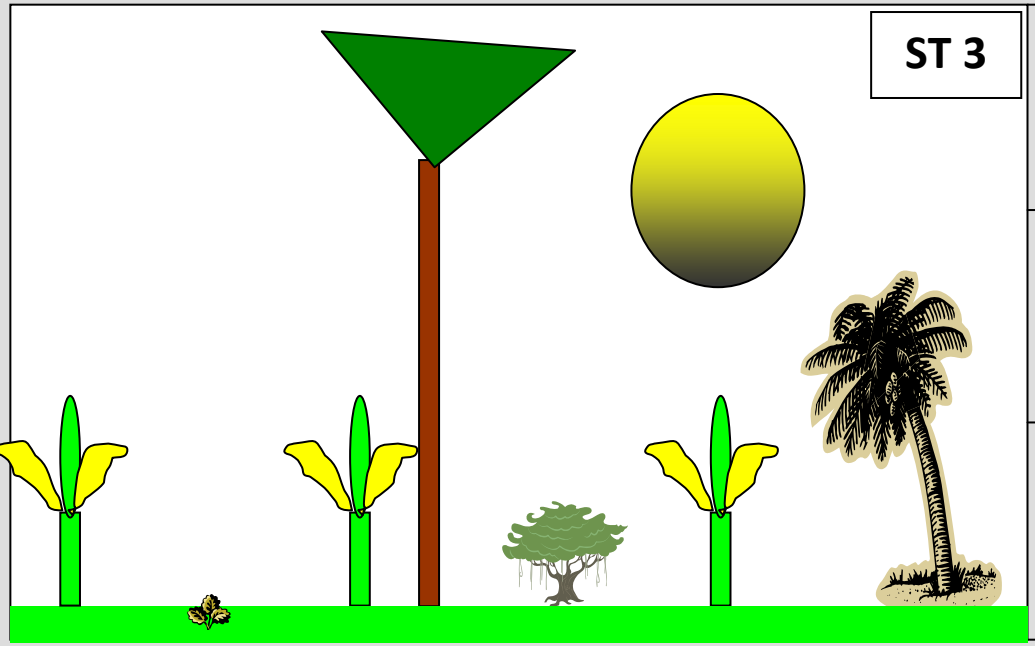
- Very low density (247) of thin associated plants distributed mainly in high stratum (25-25-50).
- Extremely high proportion of trees (86%)
- Very low proportion of Musacea and Palmacea

- Very high shade level at 1m height.

- High density of young, very high and thick cocoa introduced varieties mixed with “local” ones (75/25).

- Ground covered with litterfall and young tree seedlings. Low prop. of grasses.

CLUSTERS DESCRIPTION

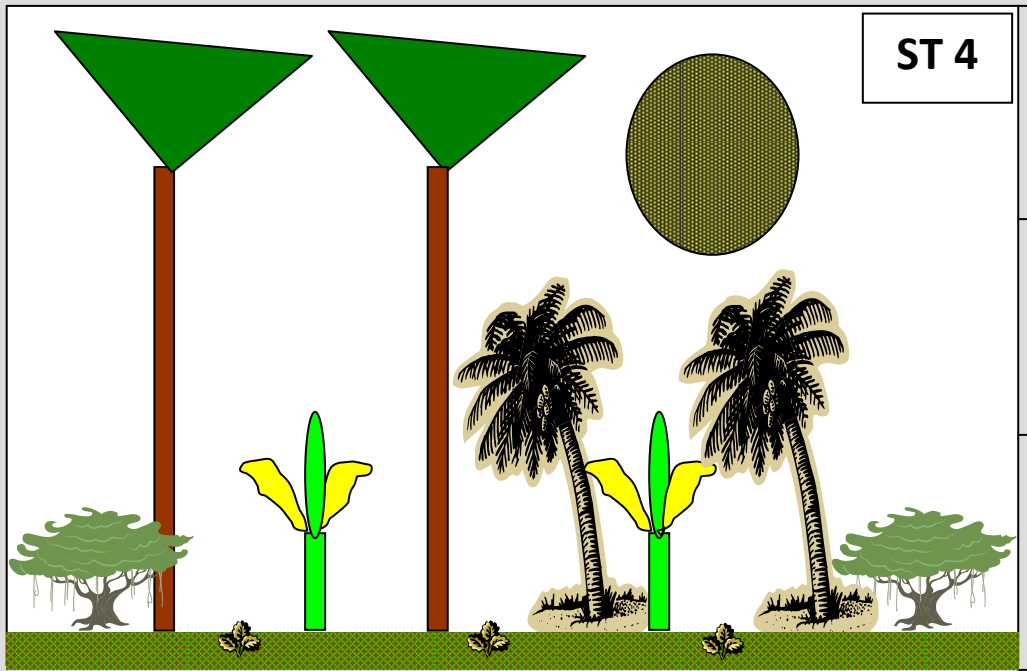


- Very high density (470) of associated plants distributed mainly in low stratum (75 %).
- High proportion of Musacea (62%)
- Low proportion of Trees and Palmacea

- High shade level at 1m height.

- Very low density (360) of old, very low, thin and pruned cocoa local varieties mixed with introduced ones (40/60).

- Ground covered with litterfall and high % of weeds. Almost no ligneous plants



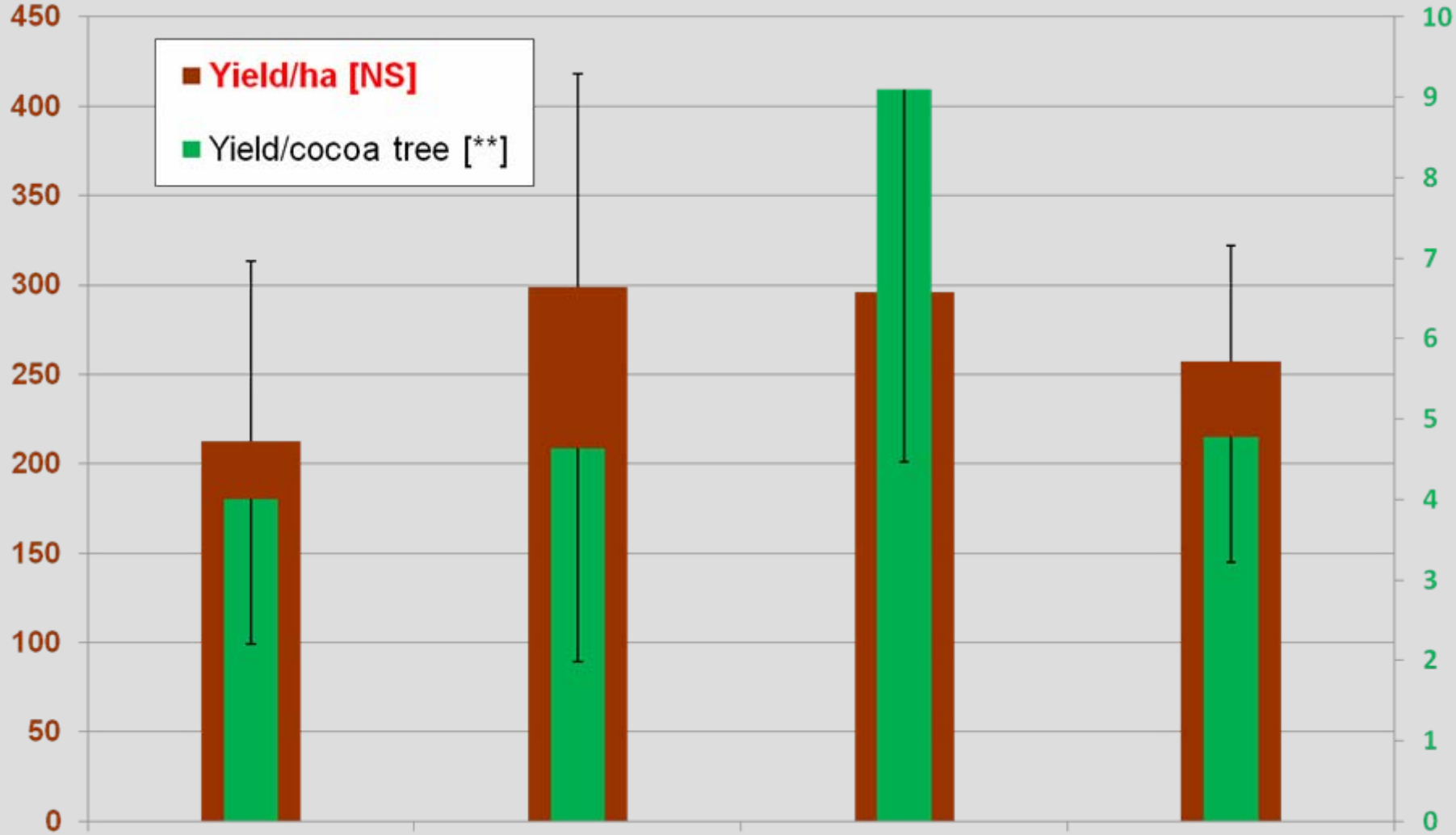
- Low density (295) of associated plants distributed mainly in low and high strata (45-20-35).
- High % of Trees and Palmacea.
- Low % of Musacea

- Very high shade level at 1m height.

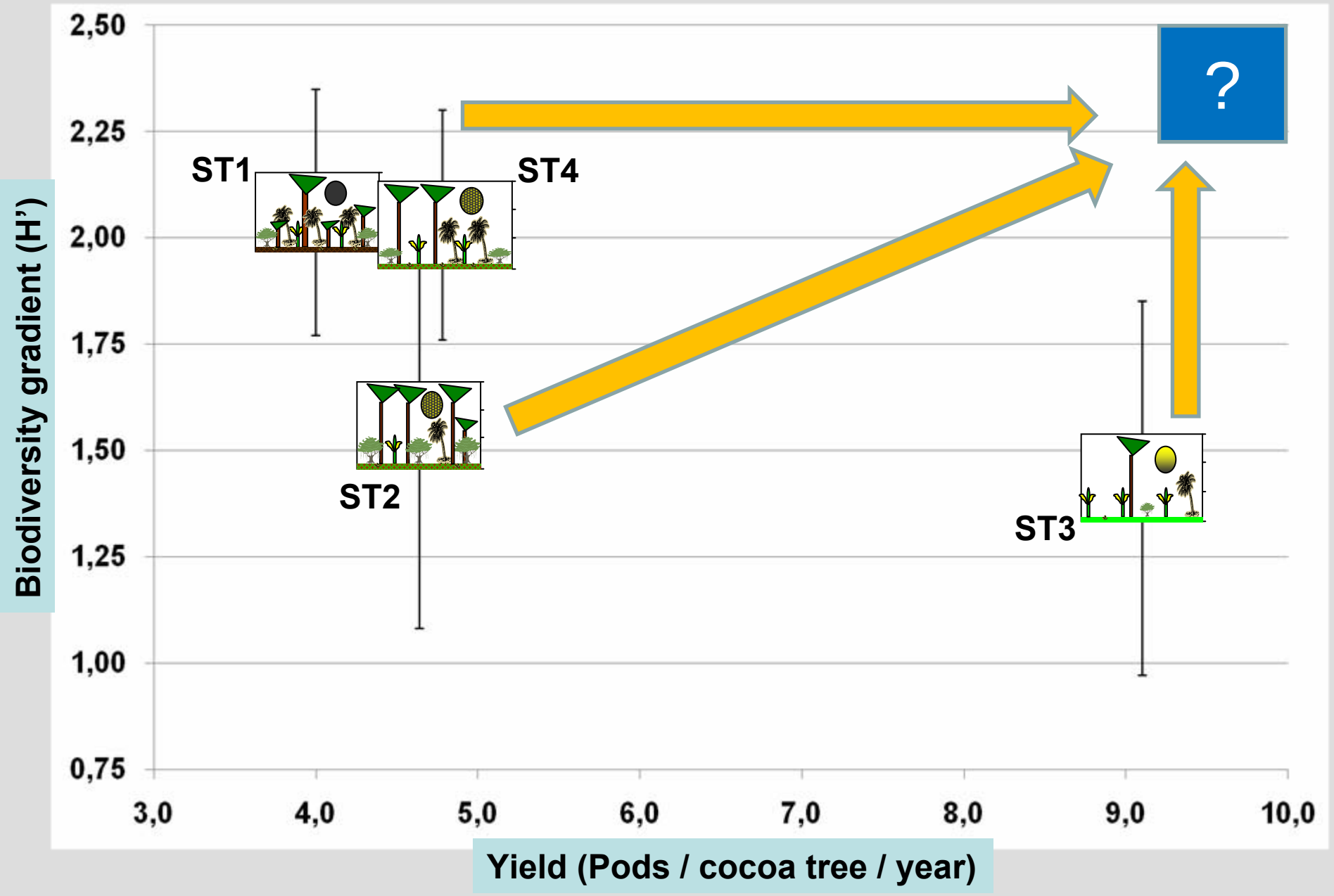
- High density (560) of low, medium aged unpruned cocoa introduced varieties mixed with local ones (75/25).

- Ground covered with litterfall and high % of trees and weeds. Floodplain pattern.

COCOA PRODUCTIVITY



Trade-offs between Yield and Structure in cocoa based AFS ?



Thank you…

… for your attention.

… to the Bribri indigenous people of Talamanca.

… to the Central American Cocoa Project (PCC),

… to CATIE and CIRAD for financial support.